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Subject: Douglas-fir Tussock Moth Monitoring in Arizona, 1994

To: Arizona Forest Supervisors

Enclosed is an evaluation of Douglas-fir tussock moth (DFTM) based on the results of the 1994 survey in central Arizona. The Douglas-fir tussock moth is an important defoliator affecting mixed conifer ecosystems in the inland west. In 1992, an early warning system to detect incipient outbreaks of the Douglas-fir tussock moth was installed in several locations of the Tonto National Forest where DFTM has been known to occur historically. These locations included the Sierra Ancha and Pinal Mountains near Globe and the Mogollon Rim (near Washington Park) above Payson. In 1993, a new site was added on the Mogollon Rim just south of Baker Butte on the Coconino National Forest. In 1994 the Arizona State Land Department added three sites, also along the rim near Pinetop, Greer and Alpine.

Survey results from 1994 indicate that visible defoliation from DFTM is not anticipated in any of the monitoring locations for 1995. DFTM populations in the Pinal mountains, which were at nearly outbreak levels in 1992, continue to decline. Populations have slowly increased in the Sierra Ancha Mountains, particularly in the Reynolds Creek drainage. Few moths were detected along the Mogollon Rim, indicating very low populations there.

The survey will be continued in 1995. With cooperation of the Arizona State Land Department, locations along the eastern Mogollon Rim near Pinetop, Greer and Alpine will be monitored. A new monitoring area, the Pinaleno Mountains, on the Coronado National Forest will be added in 1995.

If you have questions or would additional copies of this report please contact Jill Wilson, at the Arizona Zone Office in Flagstaff, (602) 556-2074, DG: J.Wilson:S28102A.

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DOUGLAS-FIR TUSSOCK MOTH MONITORING IN ARIZONA, 1994

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ABSTRACT

In 1992 an early warning system to detect incipient outbreaks of the Douglas-fir Tussock moth was installed at several locations in central Arizona. Moth populations have been monitored on an annual basis since then. Trap results from 1994 indicate that populations are at low levels at all monitoring locations, with no locations exceeding the 25 moth threshhold per trap. However trap catches at one location in the Sierra Anchas are very close to this threshhold, averaging 24 moths per trap in 1994. Comparing 1992 through 1994 trap results suggests that populations continue to decline in Pinal Mountains but may increasing along the Mogollon Rim and in the Sierra Anchas. Visible defoliation is not anticipated in any of the monitoring areas in 1995. Future Forest Pest Management survey plans, general management considerations, and technical information on the biology, and effects for DFTM are discussed.

INTRODUCTION

Outbreaks of the Douglas-fir tussock moth, DFTM, Orgyia pseudotsugata, occur periodically in some mixed conifer forests of the Southwest. During outbreaks, defoliation of white fir and Douglas-fir can be severe and can result in both top-killing and tree mortality.

In Arizona, there are two known historic outbreak areas, the Pinal Mountains and Sierra Ancha Mountains, near Globe on the Tonto National Forest (Lessard 1975). The last known outbreak occurred in these locales in the late 1960's and early 1970's (Lessard 1975) when 800 acres was defoliated on Baker Mountain in the Sierra Anchas and 400 acres sustained moderate to heavy defoliation on Signal Peak in the Pinals. The largest outbreak in these areas occurred in the late 1950's when 3,000 acres were defoliated on Signal Peak, and 5700 acres sustained defoliation in the Sierra Anchas. The known distribution of DFTM in Arizona also includes the Mogollon Rim, and Mt. Graham (Lessard 1975).

The DFTM is very difficult to find except during outbreaks, which can develop rapidly and with little notice. To assist with providing some advance notice of outbreaks, an early warning system was developed in the 1970's (Daterman et al 1974) and is now used throughout much of the Intermountain West. This survey system uses traps baited with a synthetic version of the female moth sex attractant or pheromone. The traps capture male tussock moths in late summer and early fall during the mating season. The number of moths caught provides an indication of the number of larvae that will be present the following spring and the potential for defoliation. When average captures exceed 25 or more male moths, visible defoliation may be expected within the next two summer seasons.

METHODS

Pheromone traps and lures were provided by the Methods Application Group, Forest Pest Management, in Fort Collins, Colorado. Traps were placed in several areas in Central Arizona (Figure 1) where DFTM has been known to occur at either epidemic or endemic levels. These areas include the Pinal Mountains, Sierra Ancha Mountains, and the Mogollon Rim (Payson, Pinetop, Greer and Alpine). The locations in Pinetop, Greer, and Alpine are new for 1994 and established by the Arizona State Land Department. In the areas selected (except Pinetop), mixed conifer forest species such as white fir and Douglas-fir, predominated. At each area, one or more plots were selected to place a set of traps (Figures 2-7). At each plot 5 traps were placed in a looping configuration, each trap separated from the next by a minimum of 75 feet (23 meters), as described by Daterman (1974). Traps were placed in a relatively open grown tree or at the edge of a dense thicket. Traps were hung in mid July, 1994 and recovered in October, 1994.

RESULTS AND DISCUSSION

DFTM populations remain low, not exceeding the 25 moth per trap threshhold at any monitoring locations (Tables 1-3). Trap catches were highest in the Sierra Anchas where the overall catch averaged 13 moths per trap. The results at Reynolds Creek were noteworthy, averaging 24 moths per trap. Catches were uniformly quite low in the Pinal mountains, where the average per trap was 0.8 moths, and along the Mogollon Rim, 1.6 moths. No visible defoliation is anticipated at any of the monitoring locations in 1996, however if populations continue to rise in the Reynolds creek area, we may see defoliation in that area sometime in the future.

TABLE 1

Summary of male Douglas-fir tussock moths caught
in the 1994 Pheromone Trap Survey, Pinal Mountain Area

Plot Name	Location	Number of DFTM by Trap					Total	Average
		1	2	3	4	5		
Icehouse	T2S R15E S5	2	0	0	0	3	5	1.0
Lower Pinal	T2S R15E S5	0	0	1	2	0	3	0.6
					Area Total		8	
					Mean/Trap		0.8	

TABLE 2

Summary of male Douglas-fir tussock moths caught
in the 1994 Pheromone Trap Survey, Sierra Ancha Area

Plot Name	Location	Number of DFTM by Trap					Total	Average
		1	2	3	4	5		
Workman Creek	T6N R14E S33	0	0	2	8	0	10	2.0
Reynolds	T6N R14E S17	16	26	23	14	41	120	24.0
					Area Total		130	
					Mean/Trap		13	

TABLE 3

Summary of male Douglas-fir tussock moths caught
in the 1994 Pheromone Trap Survey, Mogollon Rim Area

Plot Name	Location	Number of DFTM by Trap					Total	Average
		1	2	3	4	5		
Washington Park	T12N R10E S14	0	2	8	3	1	14	2.8
Baker Butte	T12N R9E S11	1	1	0	0	0	2	0.4
Pinetop	T9N R23E S31	0	0	0	0	0	0	0.0
Greer	T7N R27E S14	0	0	0	0	0	0	0.0
Alpine	T5N R30E S22	2	0	0	0	0	2	0.4
					Area Total		18	
					Mean/Trap		0.7	

Examining results since 1992 revealed some interesting trends (Table 4). Catches in the Pinals were highest in 1992 and have declined ever since while those in both the Sierra Anchas and the Mogollon Rim have demonstrated an increasing trend over the same time period. It is curious that the trends are not more synchronous, however we understand much less about endemic level DFTM populations than we do about outbreaks which are generally reported to occur at the same time across wide geographic areas.

Table 4

Average number of male Douglas-fir tussock moths caught in pheromone-baited sticky traps in central Arizona during 1992-1994

Location	Mean Number of Moths per trap per year		
	1992	1993	1994
Pinal Mountains			
Icehouse	38.2	10.8	1.0
Lower Pinal	32.5	15.6	0.6
Sierra Anchas			
Aztec Peak	1.6	2.8	---
Workman Creek	0.0	1.2	2.0
Reynolds Creek	7.2	17.2	24.0
Mogollon Rim			
Washington Park	0.0	3.4	2.8
Baker Butte	---	0.0	0.4
Pinetop	---	---	0.0
Greer	---	---	0.0
Alpine	---	---	0.4

FUTURE SURVEY PLANS

Since catches did not exceed the 25 moth threshhold at any of the monitoring locations, larval sampling is not planned for any of these sites in 1995. Pheromone traps will be placed in all the same locations as in 1994. If road conditions in the Aztec Peak area are improved that site will be sampled once again. One additional area will be added in 1995, the Pinaleno mountains near Safford. Defoliation as well as larvae were observed there on the north slope of West Peak during a visit to examine bark beetle mortality in early August. This population was evaluated in mid October. There will be a separate report concerning this situation prepared by Michelle Frank, Entomologist, Arizona Zone.

GENERAL MANAGEMENT CONSIDERATIONS

Management recommendations to prevent or reduce adverse impacts from tussock moth outbreaks involve four major activities: monitoring and early detection, evaluation, suppression, and prevention. Early detection can be accomplished using pheromone traps to catch male moths, cryptic shelters to catch pupating adults or cocoon sampling. Populations trends can be determined by continuous annual monitoring. Determination of appropriate environmentally acceptable, economically sound tussock moth strategies requires a good understanding of desired future conditions and resource management objectives from a site specific and a landscape perspective.

The need to suppress a tussock moth population depends on the impact an uncontrolled outbreak is expected to have on the accomplishment of resource management objectives. Decisions for control must be based on a thorough evaluation of the insect population (expected trends etc.) and the resource values at stake. A number of materials are registered for suppression of DFTM outbreaks. Some are very selective and affect only the tussock moth, others are more broad spectrum. Should the need for suppression be considered a specialist from the zone Entomology and Pathology staff should be consulted.

Prevention of serious outbreaks, particularly those that are outside the known range of natural variability, is the ultimate goal of pest management under ecosystem management. Unfortunately in the Southwest our knowledge of outbreak history, insect-host relations and stand dynamics is limited compared to other regions of the west. In general, outbreaks are confined to old, multi-storied stands of white fir and Douglas-fir, without a history of logging (Stoszek and Mika 1979). White fir sustains higher defoliation than Douglas-fir. Outbreaks tend to occur in lower elevations, where the amount of precipitation restricts growth of white fir. Stoszek and Mike (1979) compared a number of studies conducted in the west on relationships between stand characteristics and outbreaks and reported that in general DFTM outbreaks are associated with conditions where tree competition for moisture and nutrients may be great: ridgetops and upper slopes, poor productivity sites, and mature and overmature multistoried stands with high density, particularly of host species. Since fir growing on pine sites and fir stands growing on warm, dry sites seem most vulnerable to DFTM, one of the most effective preventive measures may be to use silvicultural treatments or prescribed fire to maintain seral pine or hardwood species in vulnerable areas.

TECHNICAL INFORMATION

Douglas-fir Tussock Moth

Introduction

The biology and effects of the Douglas-fir Tussock Moth are described in detail by Wickman et al (1975) and Brookes et al (1978). The Douglas-fir Tussock Moth, Orgyia pseudotsugata (McDunough) is an important defoliator of true firs and Douglas-fir in Western North America. Outbreaks develop rapidly and then usually subside after a year or two, usually lasting for a total of 4 years. During outbreaks, defoliation can be severe.

Biology and Life Cycle

In the Southwest the tussock moth has two hosts, white fir and Douglas-fir. White fir is the preferred host in this region. Though its name may seem a misnomer in this area, Douglas-fir is the preferred host in the northern part of its range in British Columbia and northern Washington.

The tussock moth produces one generation per year. Adults appear from late July into November. While males fly, females moths are flightless and have only rudimentary wings. The female attracts males by emitting a sex

pheromone. After mating she lays an egg mass which is coated with hairs. Eggs hatch in late May or early June, coinciding with bud burst and shoot elongation of host trees. Larvae then crawl to the new needle growth and begin feeding. Larvae grow and feed, passing through 6 instars before pupating in July. Dispersal occurs during the larval stage when young larvae can be carried by the wind.

Many natural controls exist that usually keep populations at low levels. These include insect parasites and predators, and birds. At outbreak levels, a nuclear polyhedrosis virus, along with the other mortality factors, causes collapse of tussock moth populations.

Effects

The direct effect of larval feeding on host trees is defoliation. The insect prefers to feed on the current years foliage, however during outbreaks, both current foliage, older foliage, and even foliage of other trees and shrubs may be consumed. Heavy defoliation can result in both outright tree mortality and top-killing. In an outbreak in eastern Oregon and Washington, 39 percent of all trees were killed in heavily defoliated areas. Top-kill in these areas amounted to between 10 and 33 percent of the trees, depending on species. Growth of defoliated trees can be retarded for several years.

Effects of an outbreak on stands can be complex. During an outbreak, growth of defoliated hosts is retarded and heavily defoliated trees may be killed or suffer top kill. Meanwhile growth of non-hosts and any undefoliated hosts can increase. After an outbreak, however, one research study showed that after 5 years, growth of surviving defoliated white firs actually exceeded that of non-defoliated white firs and non host pines (Wickman 1980). In fact for several decades after the outbreak studied, the growth of defoliated trees exceeded that for non-defoliated hosts and non hosts.

Ecosystem level effects of defoliation and tree mortality are many. Defoliation and tree mortality can lead to reductions in transpiration and consequently reduced soil water depletion in the short term. Streamflows can be increased after heavy defoliation. Nutrient distribution and availability can be altered. Forest plant species composition can be altered both directly and indirectly. Direct effects occur as a result of tree mortality and can result in species shifts towards non host tree species. Indirect effects result from environmental changes which occur following defoliation and can also result in altered plant species composition.

ACKNOWLEDGEMENTS

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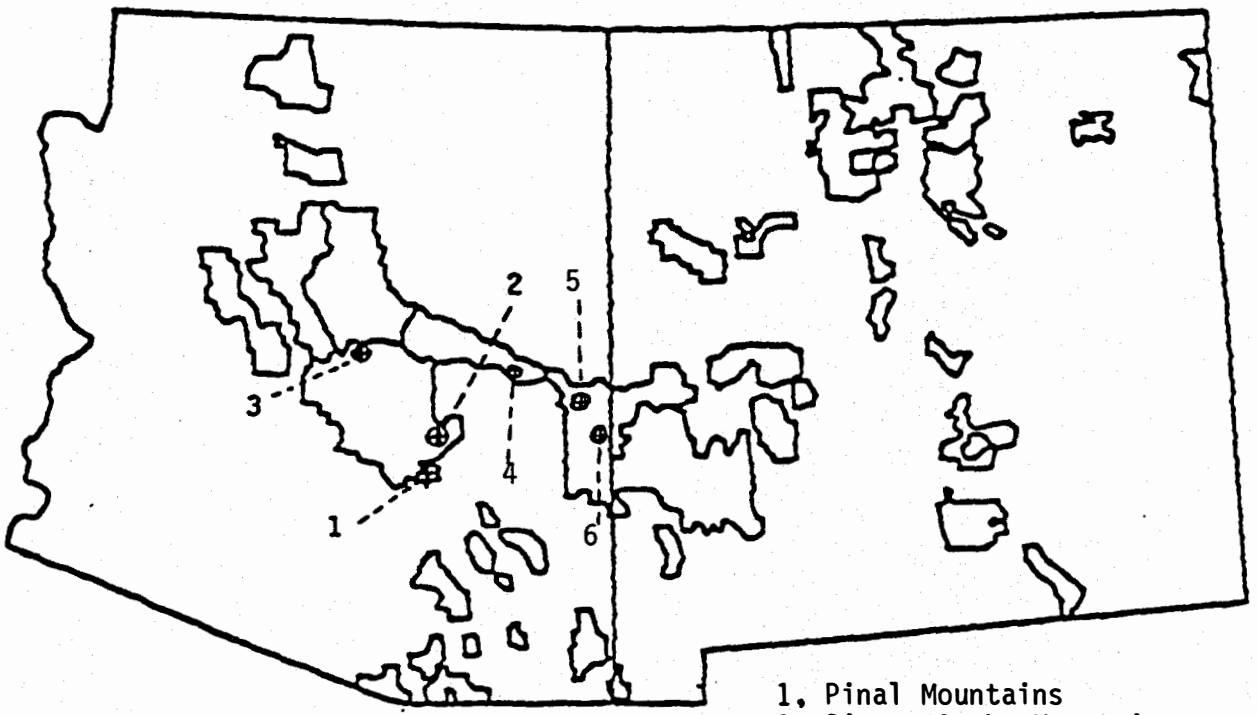
FIGURE 1

DFTM Outbreak Early Warning
Detection System Sites
Arizona 1994



1. Pinal Mountains
2. Sierra Ancha Mountains
3. Mogollon Rim, Payson
4. Mogollon Rim, Pinetop
5. Mogollon Rim, Greer
6. Mogollon Rim, Alpine

FIGURE 2

1994 DFTM Pheromone Trap Plots
Pinal Mountains

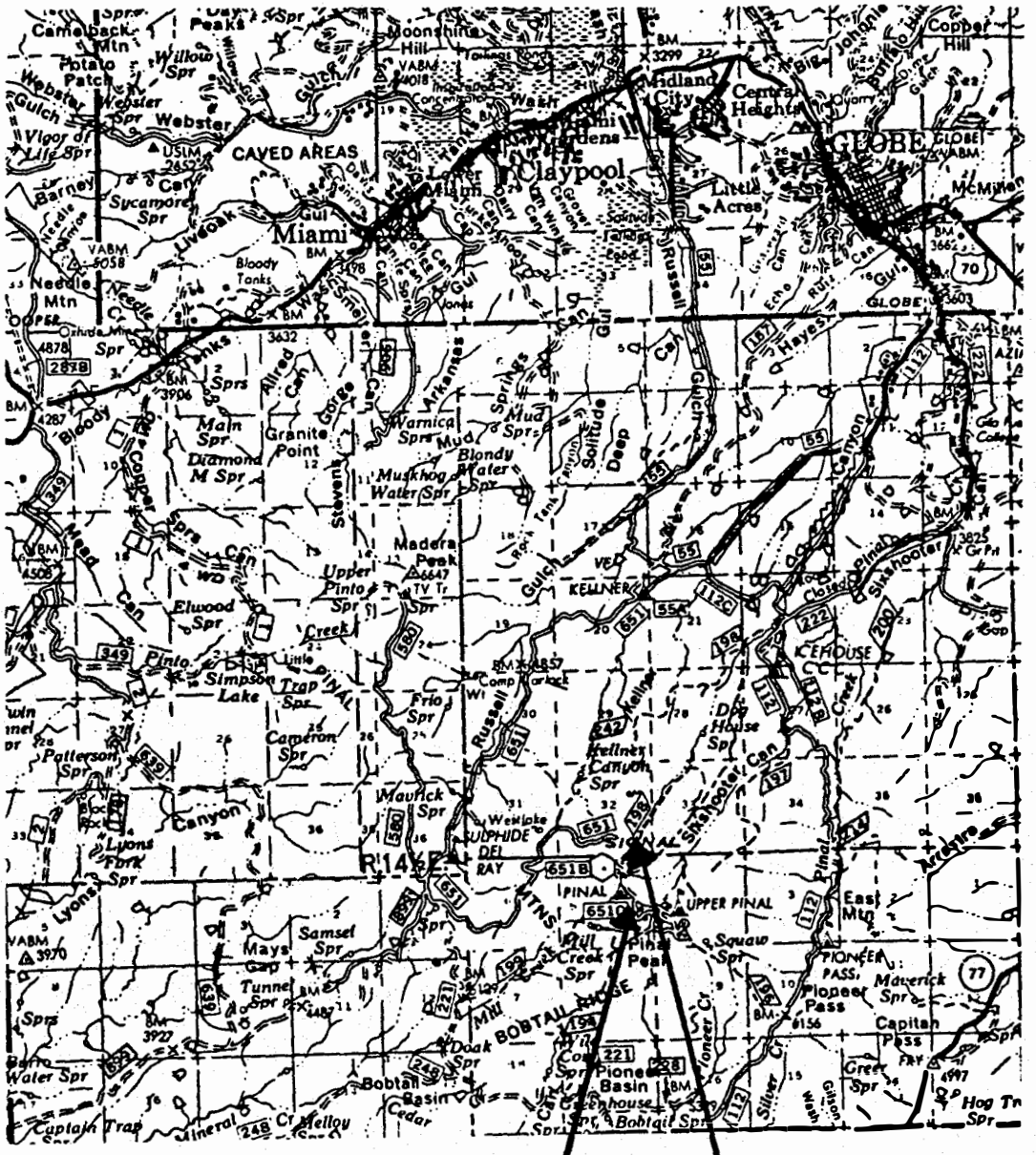


FIGURE 3

1994 DFTM Pheromone Trap Plots
Sierra Ancha Mountains

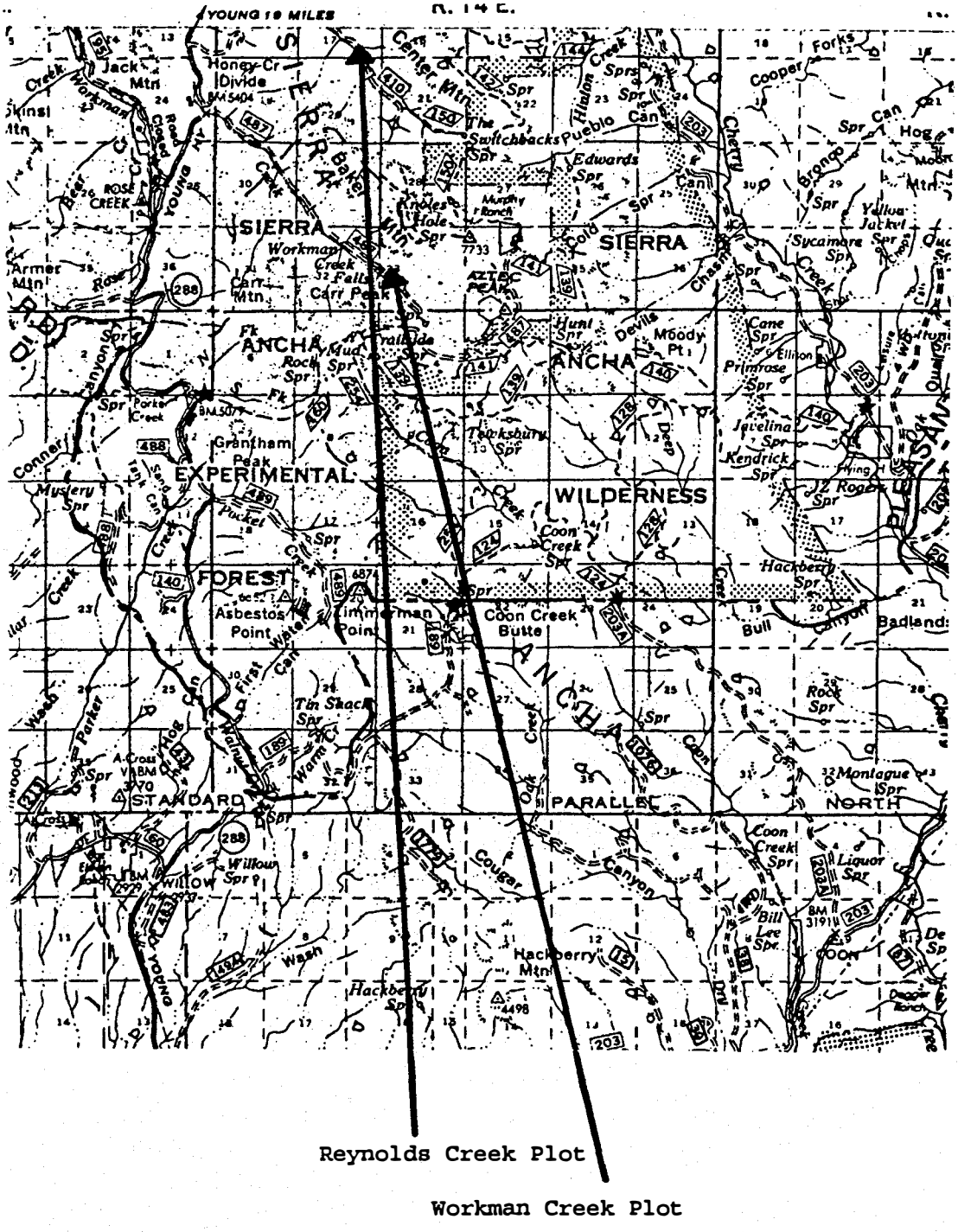


FIGURE 4

1994 DFTM Pheromone Trap Plots
Mogollon Rim, Payson

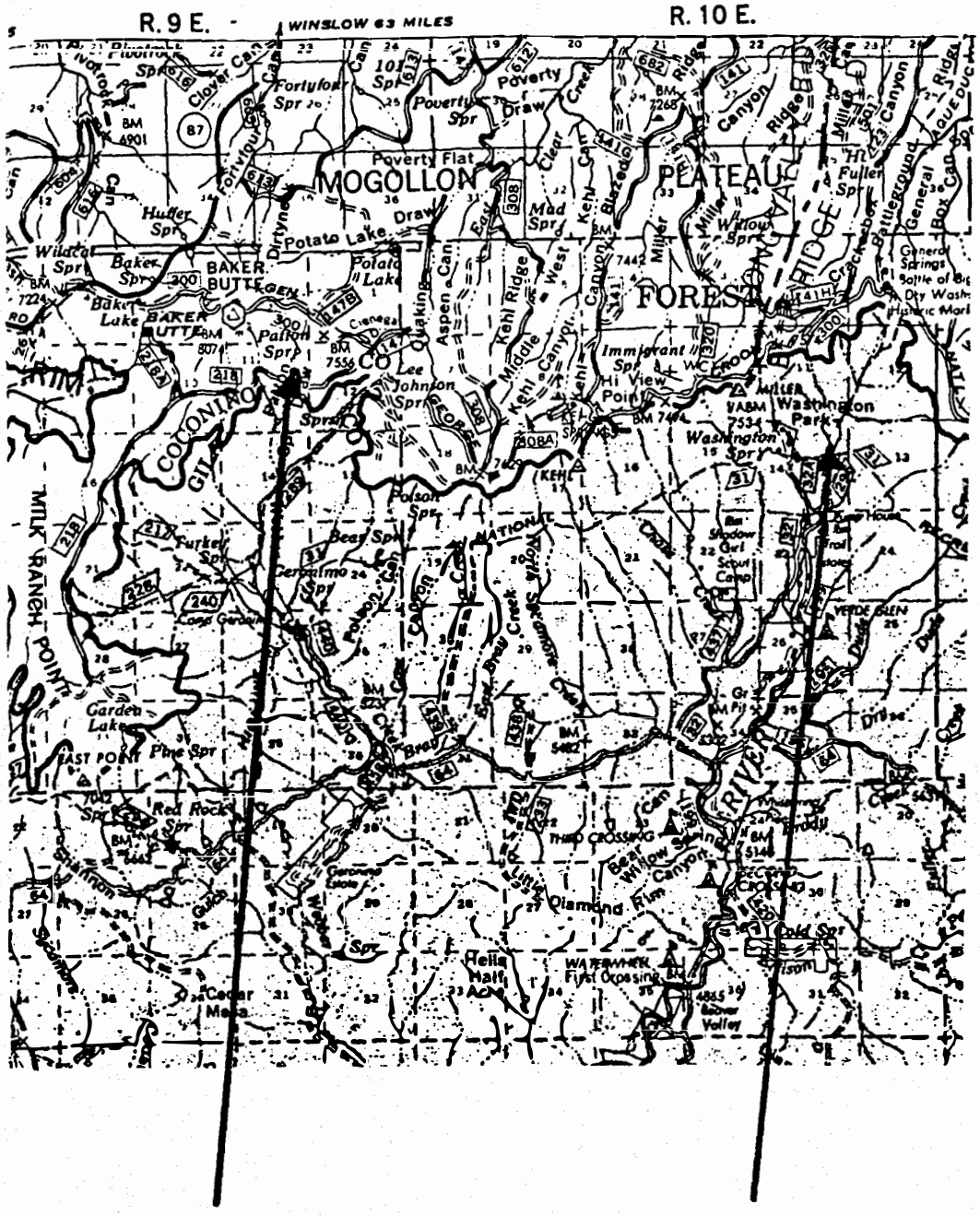


FIGURE 5

1994 DFTM Pheromone Plots
Mogollon Rim, Pinetop

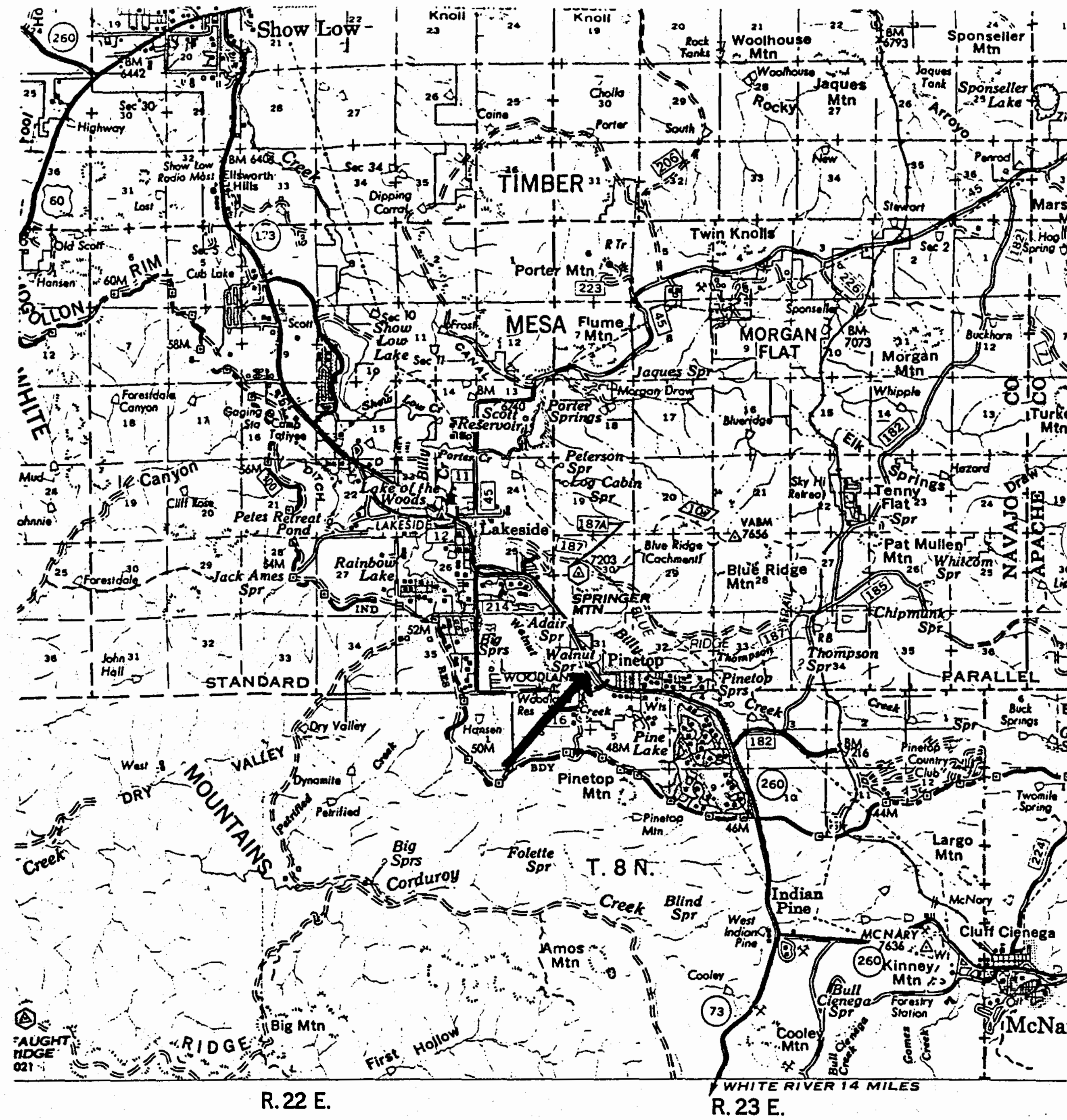


FIGURE 6

1994 DFTM Pheromone Trap Plots
Mogollon Rim, Greer

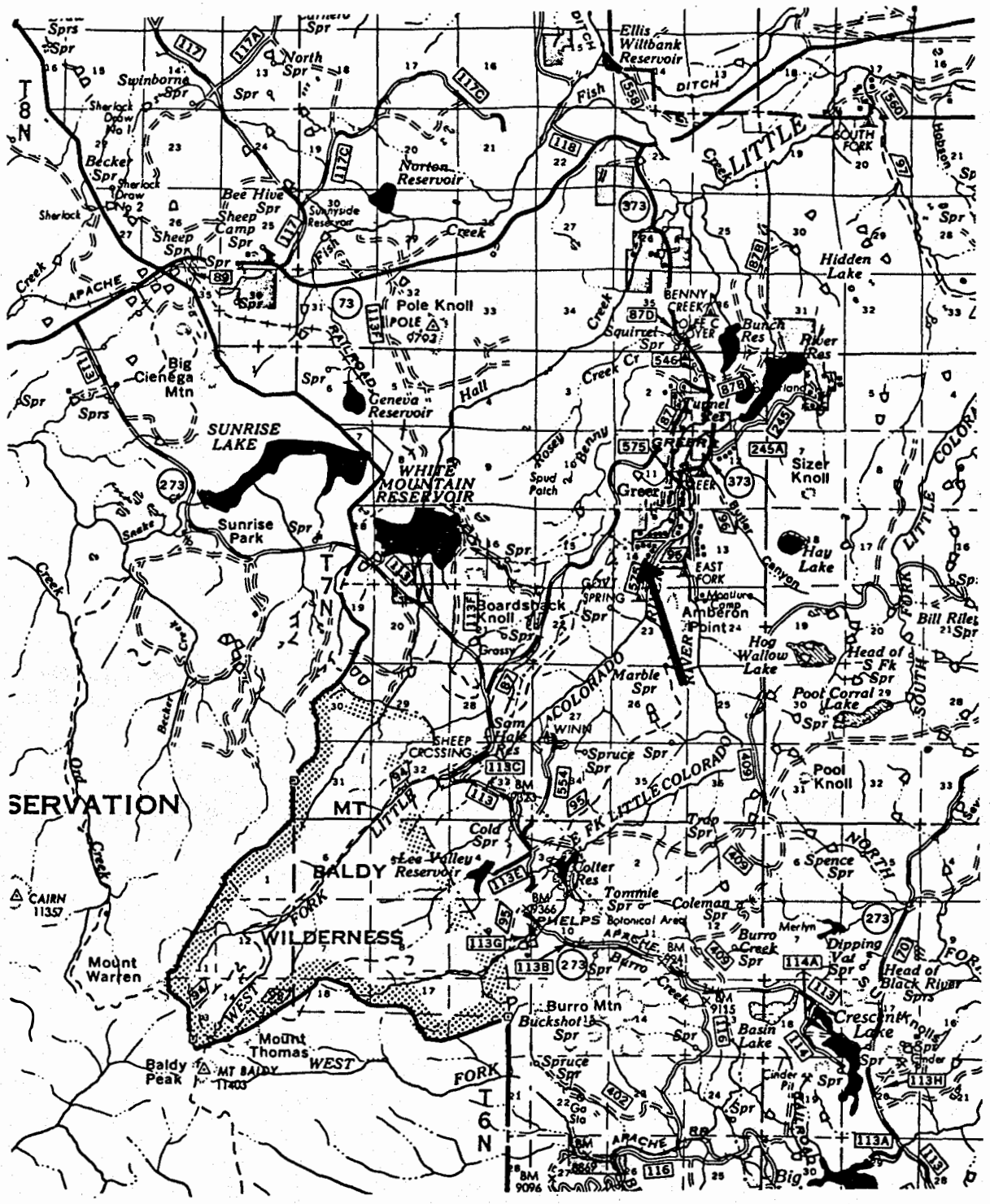


FIGURE 7

1994 DFTM Pheromone Trap Plots
Mogollon Rim, Alpine